# Space Weather Technical Forecast

Issued on Friday, 03 December 2021 at 13:13 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Chance of G1/Minor Storm activity mainly day 1 (3rd) or early day 2 (4th)**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity was very low, with only low B-flares observed. There are currently four sunspot regions on the visible disc. AR2898 Hsx/alpha is near the southwest limb and soon to rotate off the Earth-facing disc, however this is now followed by a newly emergent Cro/Beta region, in a plage area just to the southeast. AR2902 Cro/beta in the northeast has continued to gradually decline. A small, new Axx/alpha region has also rotated onto the southeast disc. No Earth-directed CMEs have been observed in coronagraph imagery, however a filament was observed leaving the Sun in SDO aia-304 imagery around 23/0800-0930 and if a CME is produced from this location, it is likely to have an Earth-directed component.

**Solar Wind / Geomagnetic Activity:** The solar wind speed, as measured by DSCOVR at L1, was slightly elevated but declined erratically from 520 km/ s to 440km/s. Although a rise from 470 to 520 km/s was observable shortly after 02/1200 UTC. Density was around average, or just above, and was notably only smoothly varying between 02/1850 UTC and 03/0700 UTC, rising to peak 11 ppcc before falling again. This has since shown a rising trend since 03/0900 UTC. The strength of the Interplanetary Magnetic Field (IMF), Bt was generally weak at below 6nT, whilst the north-south component of the field, Bz initially fell to -5nT (southward pointing), before gradually rotating back to positive (northward) peaking 3nT. Since 03/0900 UTC Bz has been predominately negative, peaking at -6nT. The Phi angle was predominantly in a positive orientation (away from the Sun). These parameters likely show a very weak glance of the anticipated CME, arriving around 02/1257UTC, with the following rotation in magnetic components indicative of a weak magnetic cloud. The transition after 03/0900 is likely the start of the CIR region, ahead of CH27. Resultant geomagnetic activity was Quiet to Unsettled levels (Kp 1-3).

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) remained at background levels. The high energy electron flux (greater than 2 MeV) was mainly High (greater than 1000 pfu) with peak at 2920 pfu at 02/1710 UTC. The associated 24-hour integrated fluence remained below the Active threshold (1e8 integrated pfu), though with a steadily increasing trend. Observed fluence at 03/0000 UTC was 1.0e8 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is likely to remain predominantly very low, with a slight chance of C-class flares.

**Solar Wind / Geomagnetic Activity:** No Earth-directed CMEs have been observed, however a filament lift from the northwest around 03/0800-0900 UTC has the potential to produce one and will be assessed once imagery is available. Fast winds from coronal hole 27 are expected to soon arrive day 1 (3rd), with solar winds likely becoming elevated. Ongoing fast wind influence is then expected day 2 (4th) and day 3 (5th), with coronal hole 28, before easing later in the period. Quiet geomagnetic activity at first is forecast to become Unsettled to Active with isolated G1/Minor storm intervals likely either later day 1 (3rd) or early day 2 (4th). Quiet to unsettled

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activity expected to return by day 4 (6th).

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is expected to remain at background levels. The high energy electron flux (greater than 2 MeV) is expected to remain at predominantly High levels, although a drop out in values is possible later day 1 and into day 2 due to the arrival of fast winds of coronal hole 27. The associated 24 hour integrated fluence is likely to remain above the Active threshold (1e8 integrated pfu) throughout, although confidence falls a little day 3 (5th) onward.

**Figure 1: Observed Solar Winds showing turbulent Bz, followed by a weak rotation in field, alongside a smooth density profile. Likely CME glance from the 29th.**

**Figure 2: SDO aia-304 showing filament lift observed 03/0800-0900**

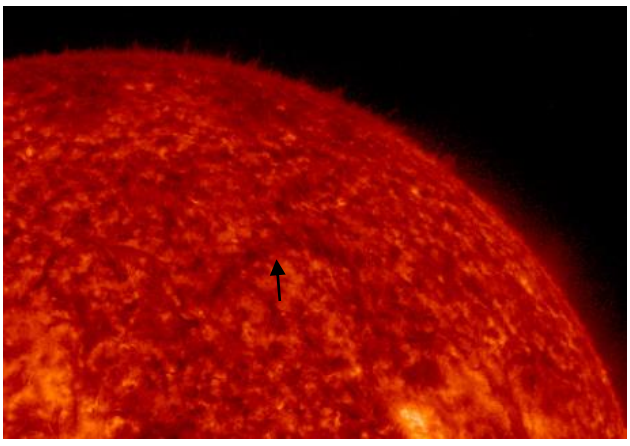

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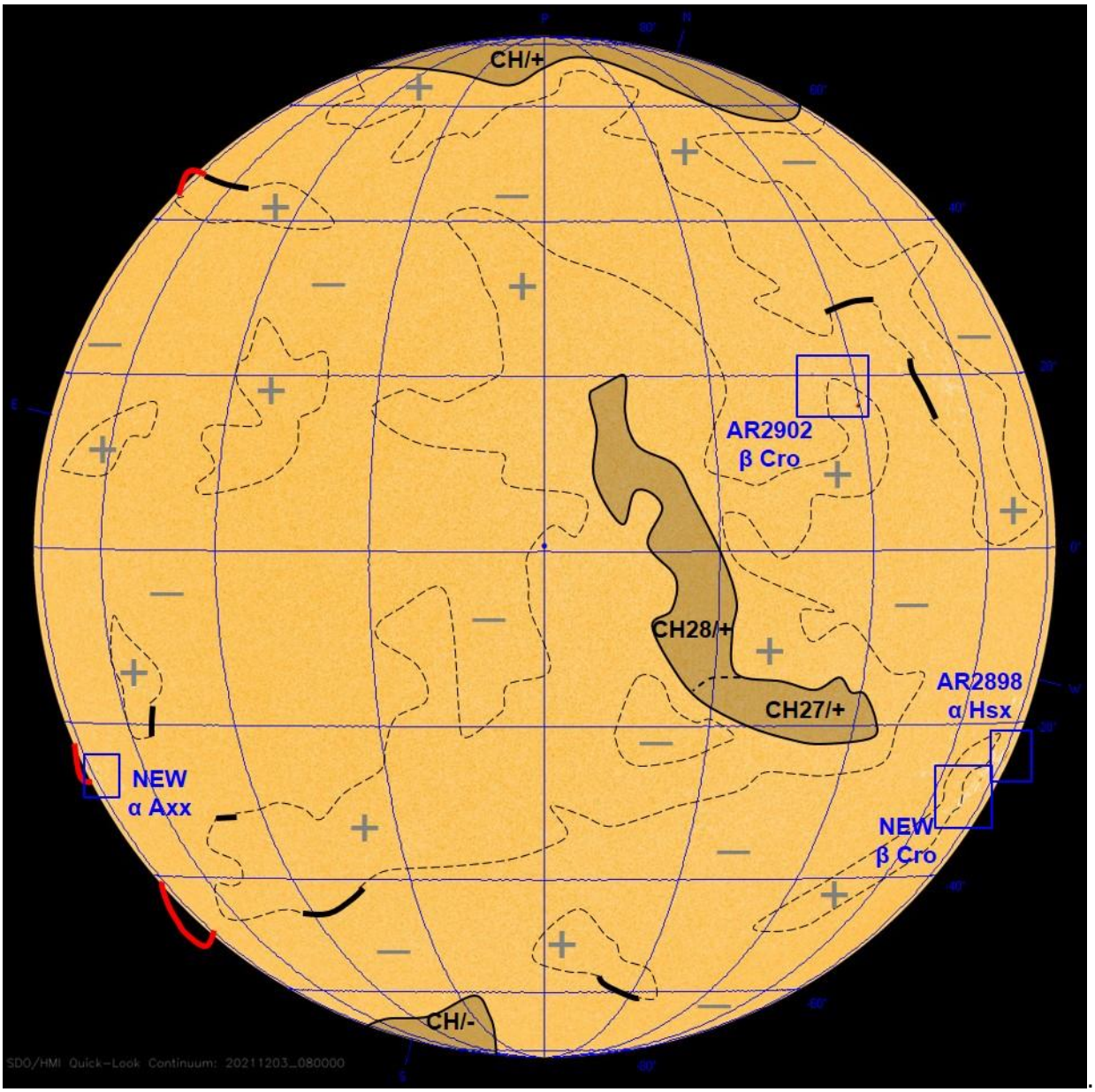
**Figure 3. Solar Analysis Valid 03/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There are currently no Earth-directed CMEs, however, a further filament has been observed leaving the Sun's northwest hemisphere, and this will be analysed once imagery is available.

The main enhancement expected over the next 12-24 hours is the arrival of the fast wind of CH27, and the subsequent transition into the fast wind of CH28. These two coronal holes extend from the southeast quadrant, northeastwards across the equator to the central northern disc. Whilst any enhancement indicated in enlil is muted, and STEREO A data is too patchy to draw conclusions, a similar positioned hole on the previous rotation led to speeds of around 600 km/s being observed. This fast wind is expected to gradually decline day 3 (5th) onward.

Geomagnetic activity is currently Quiet, but expected to soon become Unsettled to Active with a chance of isolated G1/Storm intervals either later day 1 or day 2, due to the onset of the fast winds of CH27 and CH28. Quiet to unsettled activity expected to return by day 4 (6th).

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 40 | 30 | 10 | 1 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

**Figure 4: SDO aia-193 of current rotation (left) and previous rotation (right)**

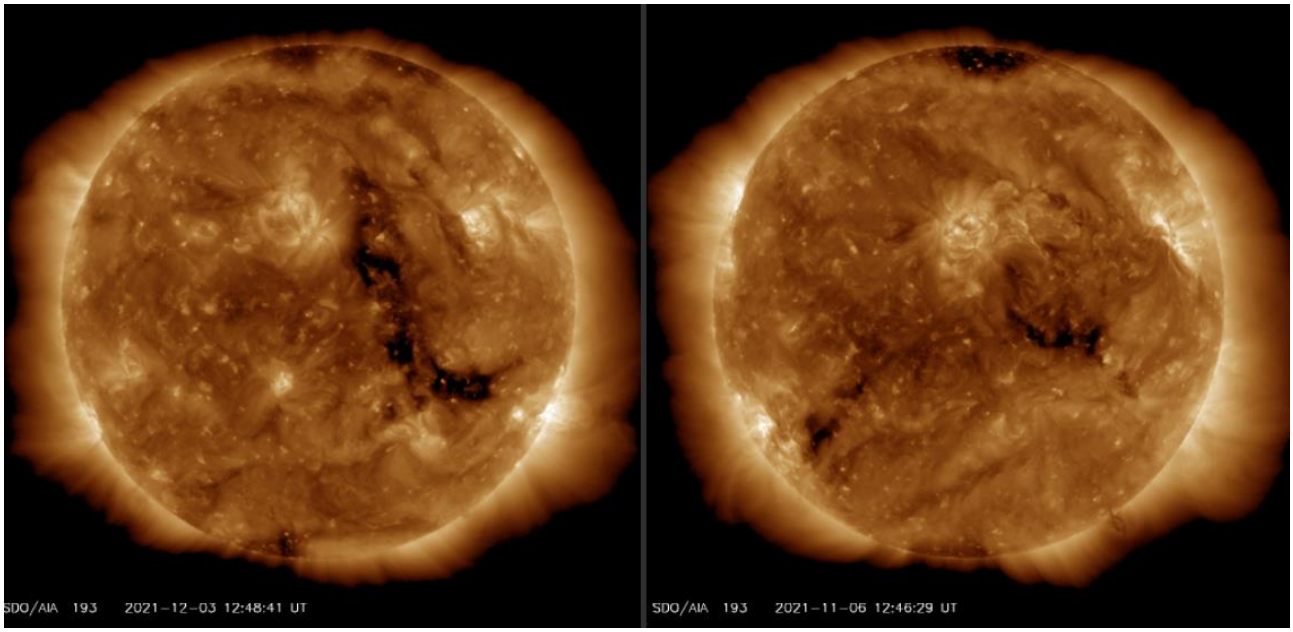


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**Figure 5: Solar Wind Persistence model – Showing potential enhancement of similar located, but smaller coronal hole. Somewhat contaminated however, by declining CME effects on last rotation.**

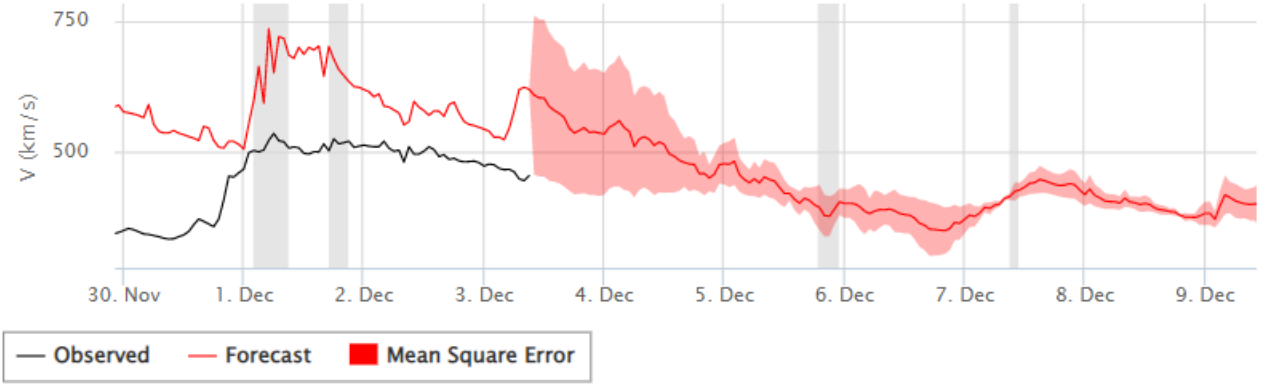
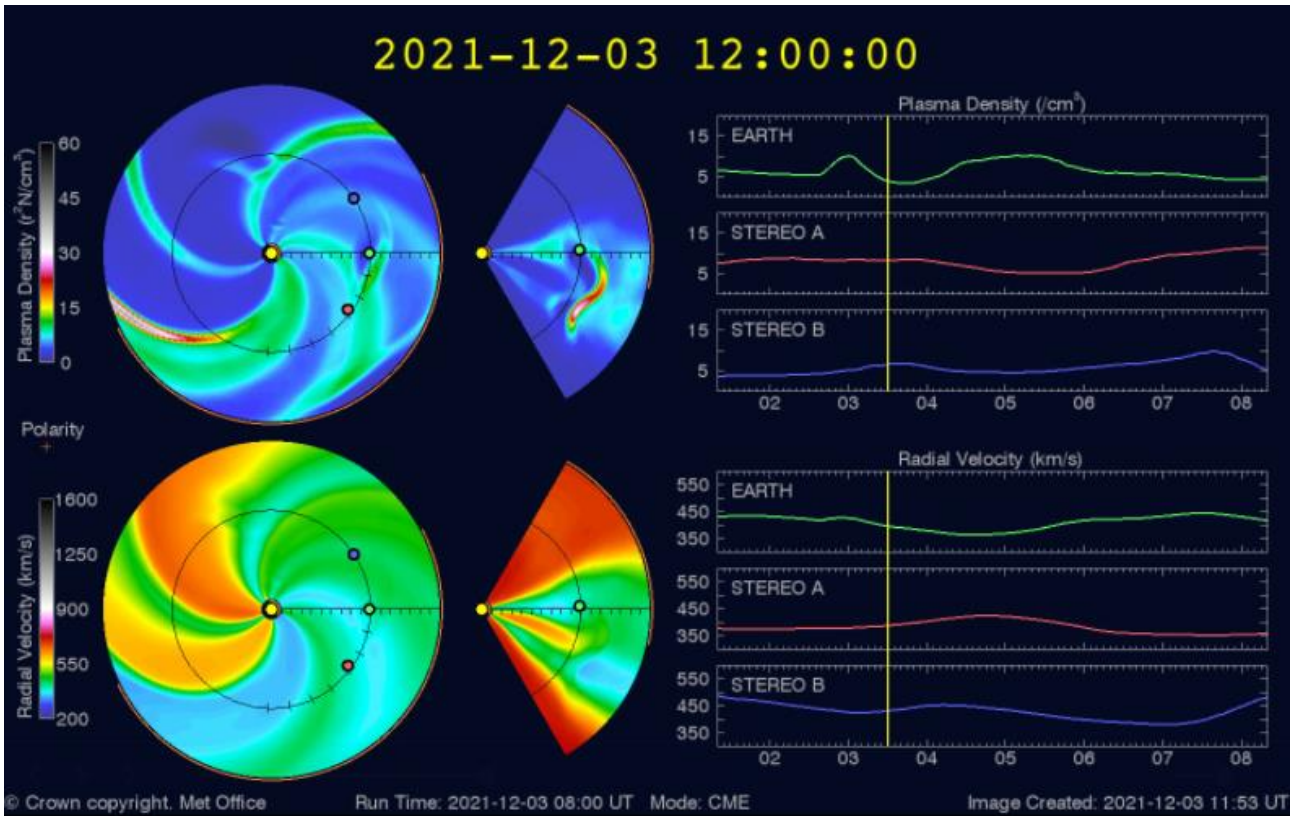



**Figure 6: Enlil, showing glancing CME yesterday, but very little enhancement from expected CH arrival**

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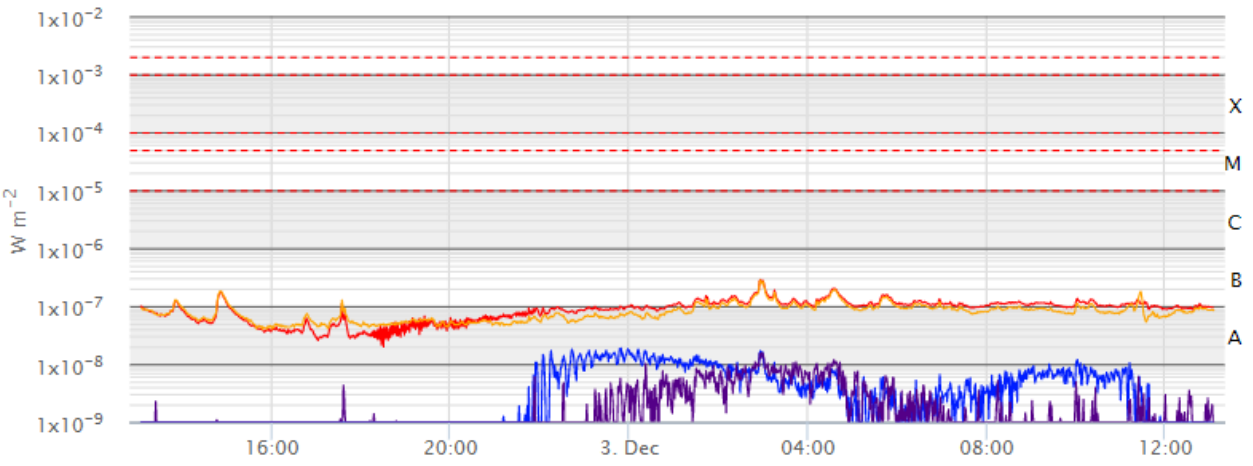
## Radio Blackouts - X-Ray Flares:

Solar Activity is currently Very Low, with only small B-class flares observed in the last 24 hours. There are currently four sunspot containing active regions on the visible disc, however they are all small, inactive and currently not expected to be the source of notable flare activity, with only a slight chance (20%) of isolated C-class flares.

AR2898 Hsx/Alpha is becoming hard to asses, and will soon rotate around the southwest limb and off the Earth-facing disc. This is followed by a new Beta/Cro emerging region in an area of plage to the southeast of AR2898. A further new Axx/Alpha region is also becoming visible near the southwest limb, however this appears to be a small and simple region with little sign of current development. AR28902 Beta/Cro in the northwest quadrant has continued to show some gradual decline.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 1 | 1 | 1 | 1 |
| Very Active | R3 to R5 X Class | No | 1 | 1 | 1 | 1 |

**Figure 7: GOES-16/17 X-ray Flux**

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## Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is forecast to remain at background levels, with no solar radiation storms anticipated.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 1 | 1 | 1 | 1 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 is currently High as a response to recent fast wind enhancements, with only a brief fall to Moderate during diurnal minima. Whilst some drop out in values is anticipated with the arrival of the fast wind of CH27/CH28 later day 1 (3rd) and into day 2 (4th), values will likely recover by day 3 (5th) to give a further period of mainly High values.

The associated 24 hour electron fluence is currently Active (greater than 1e8 integrated pfu), and despite flux levels potentially dropping out later day 1 (3rd), this is expected to remain above the Active level until at least later day 2 (4th). Confidence for Active fluence is then lower day 3 onward, however this remains likely, due to flux levels being forecast to recover to be mainly high from day 3 (5th) onward. REFM is currently giving a good indication day 1, but reducing values too quickly beyond this period.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | Yes | 100 | 99 | 80 | 80 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 5 | 5 |

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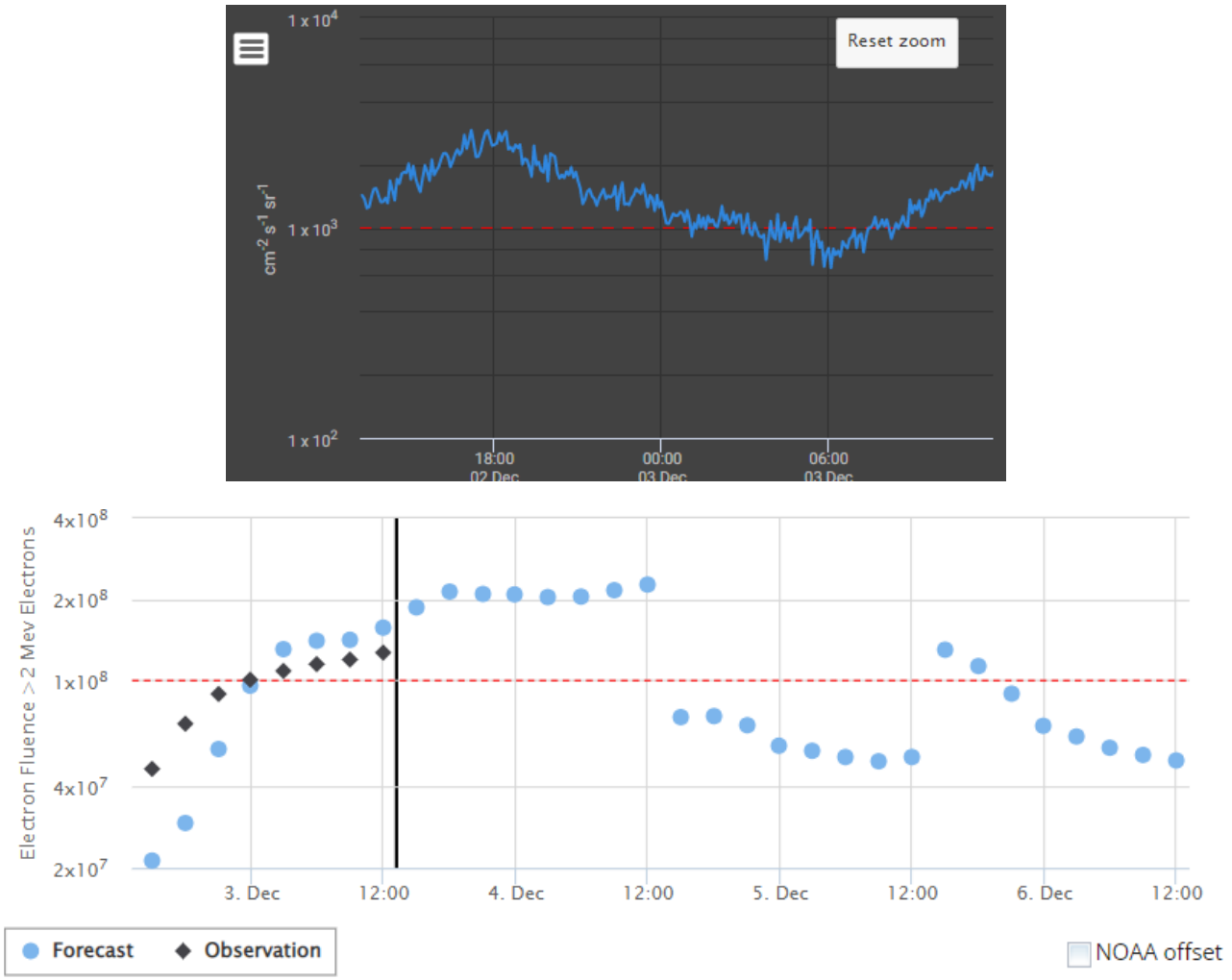
**Figure 8: GOES-16 >2 MeV Electron Flux (top) and associated 24 hour Fluence with REFM (bottom)**

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